DYNAMIC – Ad-hoc network-wide traffic detection

German Aerospace Center
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German Aerospace Center (DLR)

Research Institution

- Aeronautics
- Space
- Energy
- Transport
- Defense and Security

Approx. 8000 employees across
33 institutes and facilities
at 16 sites

Total income 2015: 891 Mio.€
(research, operations, management)

Space Agency

Project Management Agency

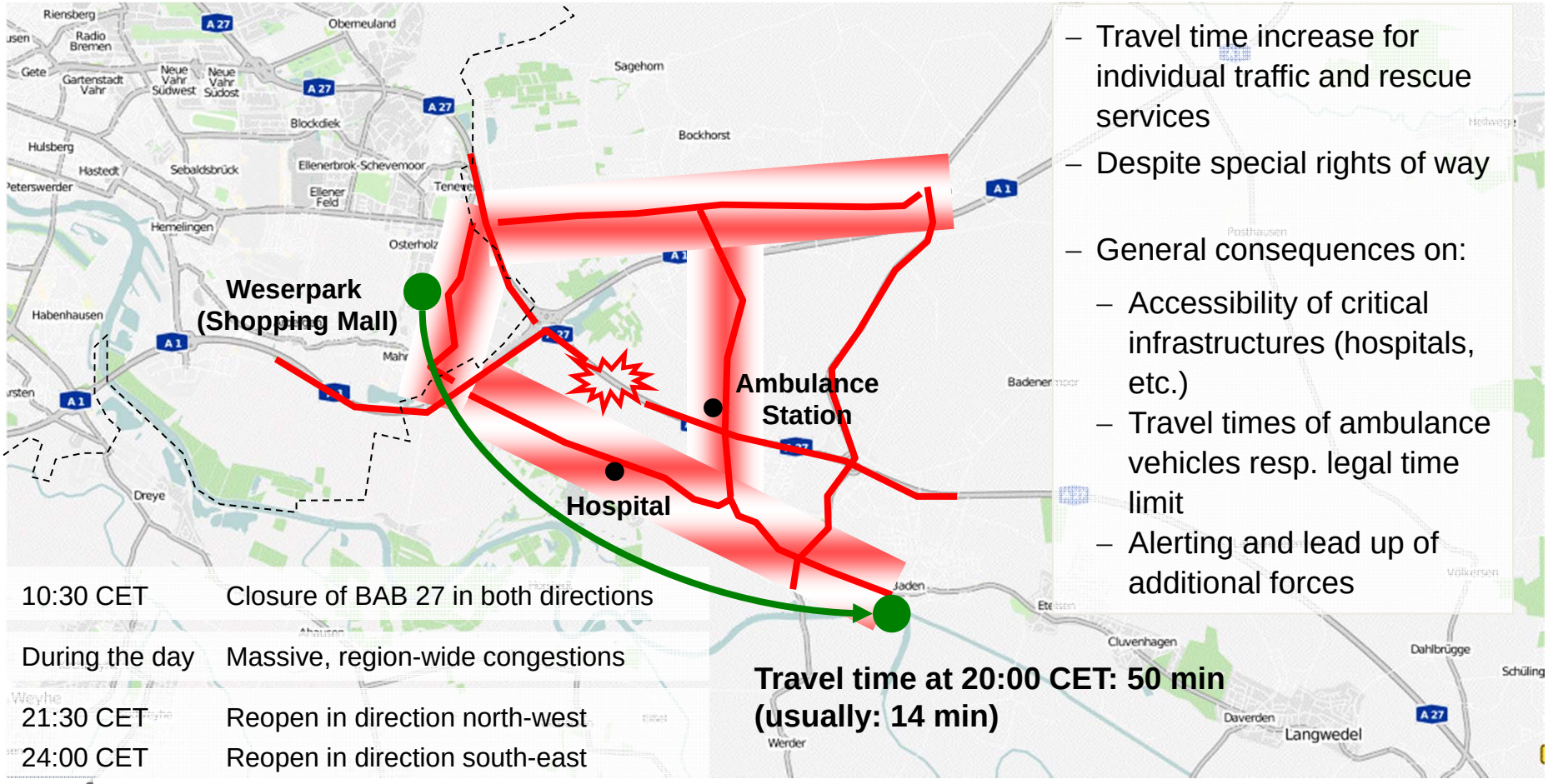
Motivation

Hazardous materials accident on motorway BAB 27 (19.05.2011)

Source: Police Verden

Motivation

Hazardous materials accident on motorway BAB 27 (19.05.2011)

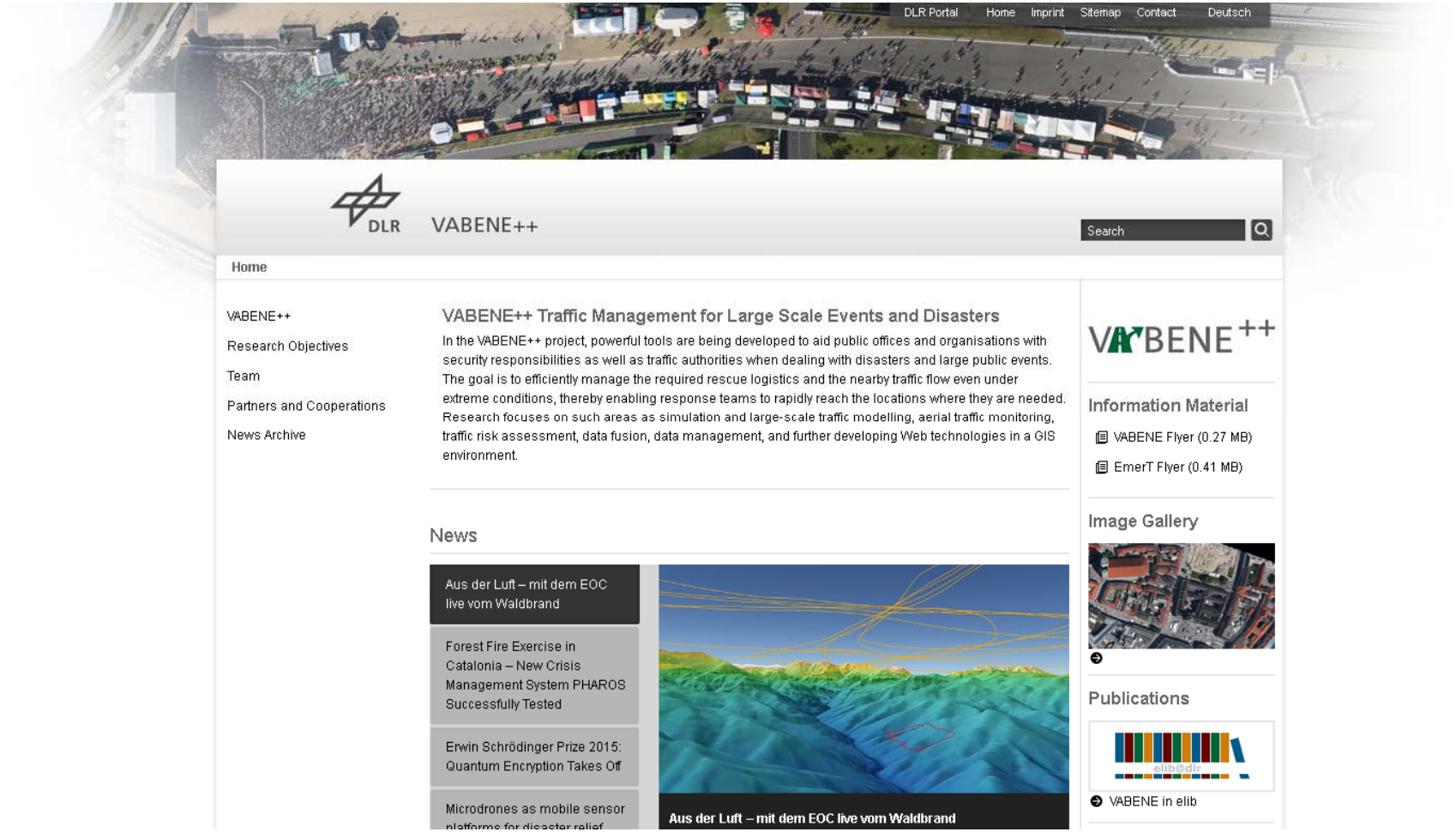


- Travel time increase for individual traffic and rescue services
- Despite special rights of way
- General consequences on:
  - Accessibility of critical infrastructures (hospitals, etc.)
  - Travel times of ambulance vehicles resp. legal time limit
  - Alerting and lead up of additional forces

10:30 CET	Closure of BAB 27 in both directions
During the day	Massive, region-wide congestions
21:30 CET	Reopen in direction north-west
24:00 CET	Reopen in direction south-east

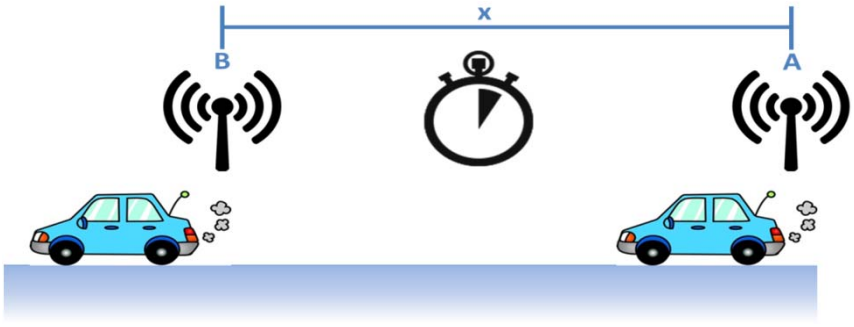
Vabene++

http://www.dlr.de/vabene/en/desktopdefault.aspx



Traffic Monitoring
using radio based technologies (e.g. Bluetooth, WiFi)

- **Principle**: Detection of mobile devices with activated Bluetooth interface (e.g. smartphones)
- **Relevant information**: time, position, unique identifier (= anonymized MAC address) → recognition at different points in network enables determination of travel times, velocities, trajectories, queuing length
- **Usage**: Stationary Bluetooth sensors are already in action for
  - Check-in times at airports
  - Visitor flow and waits in front of retail shops
  - Passenger flow analysis in public transport
  - Visitor counts at events (fairs, exhibitions, …)

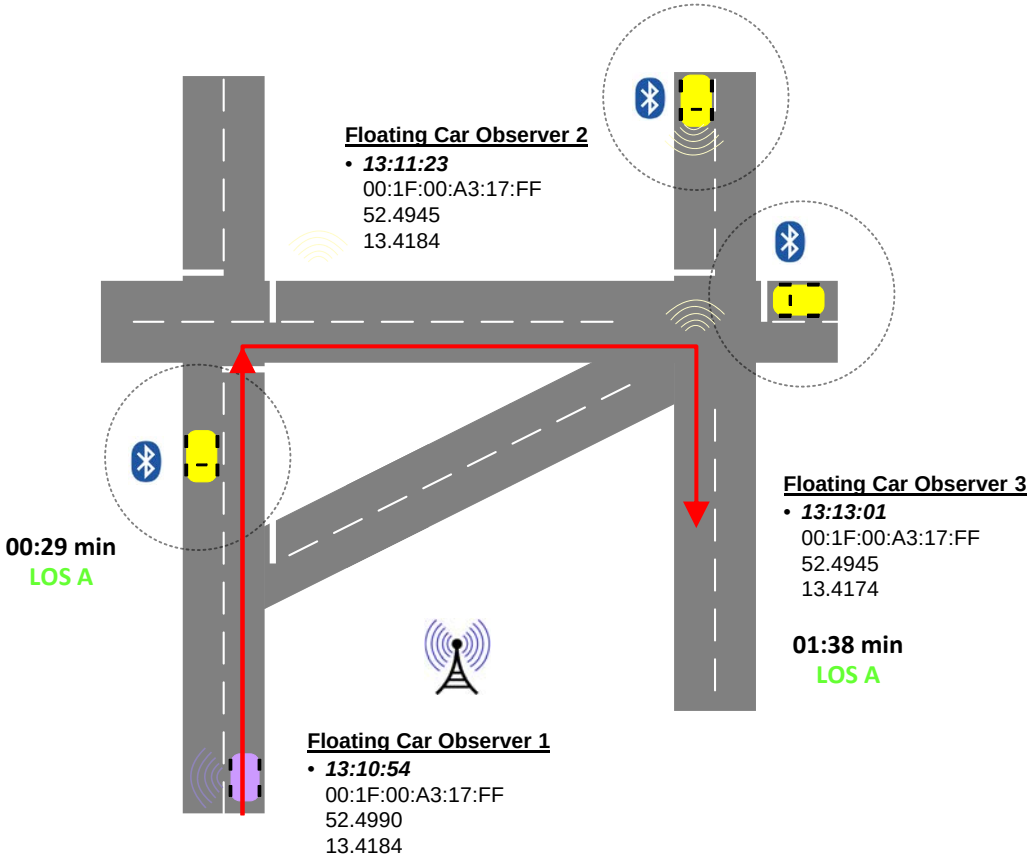


Quelle: http://shop.cancom.de/ressourcen/artikelbilder/feat_galaxygio_02.jpg

Traffic Monitoring
using Bluetooth-Floating Car Observer („DYNAMIC“)

DYNAMIC principle

- Mobile Bluetooth monitoring (combines FCD and FCO)
- Observers are part of traffic flow while they detect other traffic objects via Bluetooth
- Enables reconstruction of trajectories and travel times



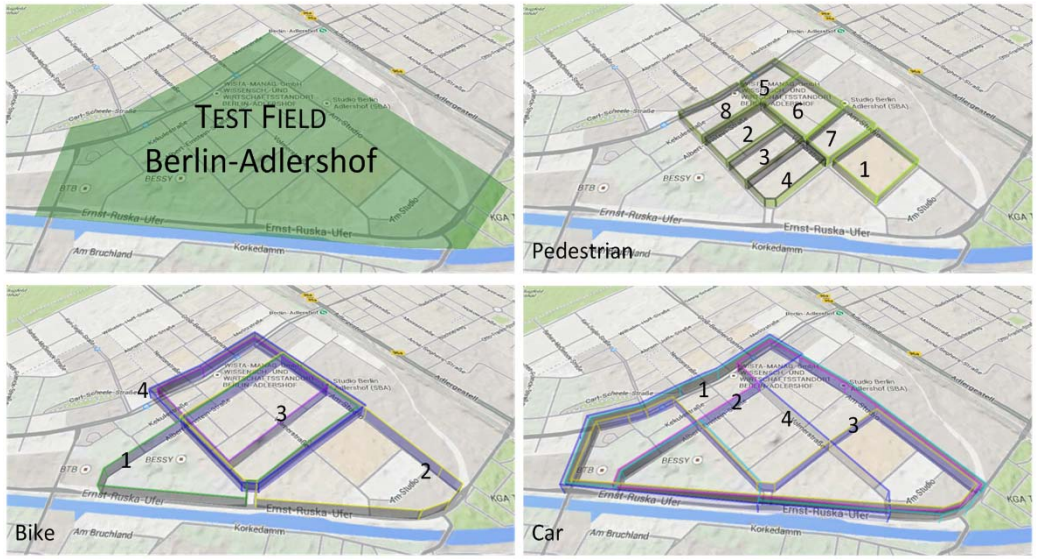
Applications
Urban mobile traffic monitoring (1)

Test field:

- Berlin Adlershof Science City (WISTA) - area of 4.2 km², home of 1,013 companies and scientific institutions
- 16 mobile sensors (different modes: 4 cars, 4 bicycles, 8 pedestrians)
- Duration: 2 hours

Goals:

- Proof of concept
- Performance analysis of sensors based on different traffic modes
- Frequency of detections and recognitions
- Generating trajectories of detected devices

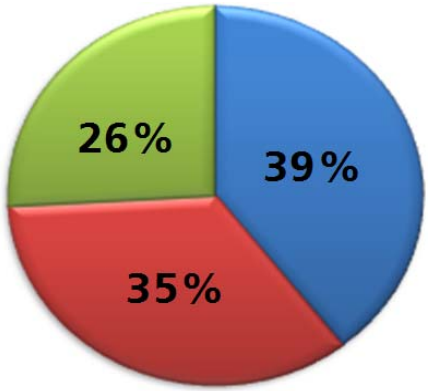


Applications
Urban mobile traffic monitoring (2)

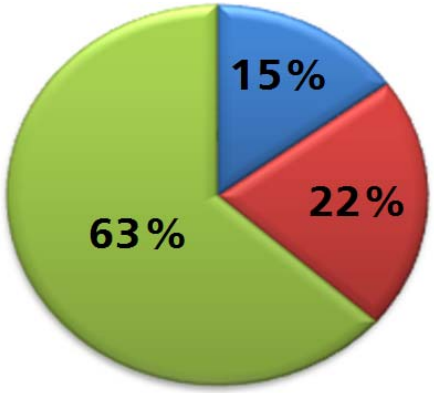
Detection rate (DYNAMIC vs. Loops):
- stationary Bluetooth sensors detect 30% of overall traffic
- mobile observers detect about 23% of overall traffic

Results:

- 8000 detected objects in total:
  - 2000 objects with unknown traffic mode (at least 831 were moving objects due to recognitions)
  - 6000 objects were detections of the observers themselves



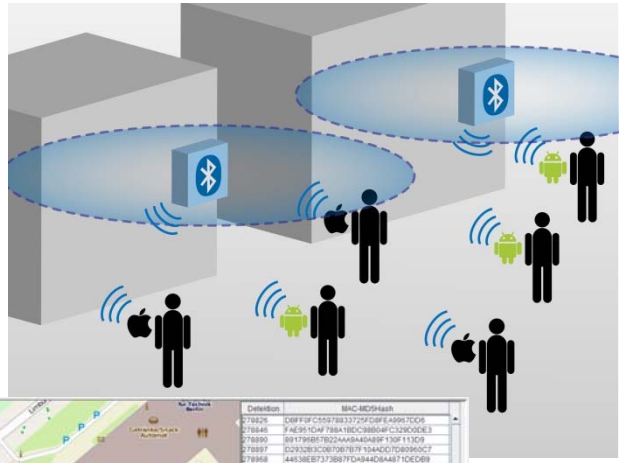
Detections per observer type



Detected traffic modes

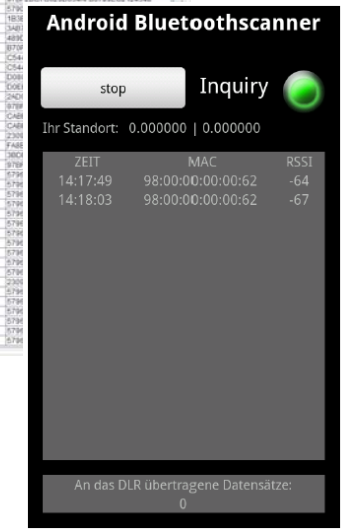
- system performs best using pedestrians as observers and observed traffic objects
  → low speeds enable better detection probability and localization

Applications
Mobile pedestrian monitoring (1)



Test field:

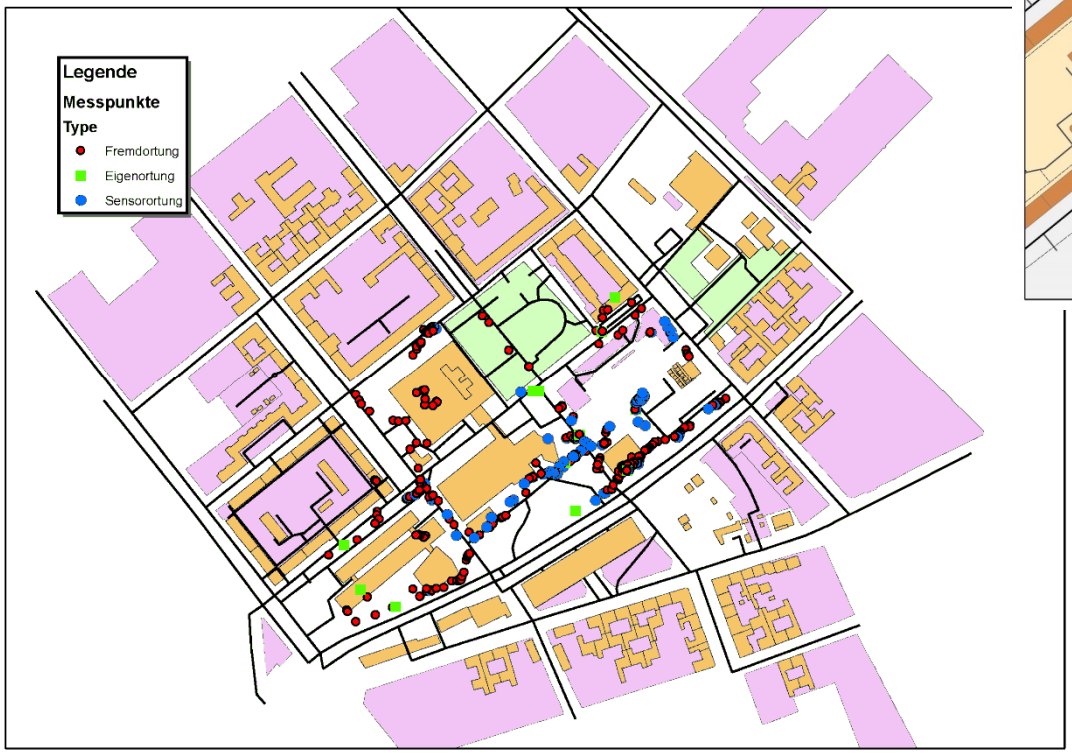
- Beuth University of Applied Sciences
- 8 stationary Bluetooth sensors
- 8 mobile Bluetooth sensors (specific smartphone application)
- Duration: 14 days (mobile measures: 2 hours/day)



Goals:

- Monitoring pedestrian flow
- Path utilization assessment
- Generating trajectories from devices which were recognized several times

Applications
Mobile pedestrian monitoring (2)



Results:

- Self localization using GPS works (= Floating ‚Car' Data)
- Indirect external localization based on Bluetooth monitoring works as well
  - Monitoring of activated Bluetooth-enabled devices (e.g. Smartphones)
  - Monitoring of other mobile observers

→ Added value: no stationary infrastructure
→ thus only minimal costs

Applications
Traffic monitoring at major events (1)

Test field:

- Wacken Open Air Festival 2015
- Ca. 80,000 visitors - approx. 50,000 persons arrived in ca. 24,000 cars
- 9 stationary Bluetooth sensors at neuralgic points along access roads
- mobile detection at festival site was not allowed by the organizer

Goals:

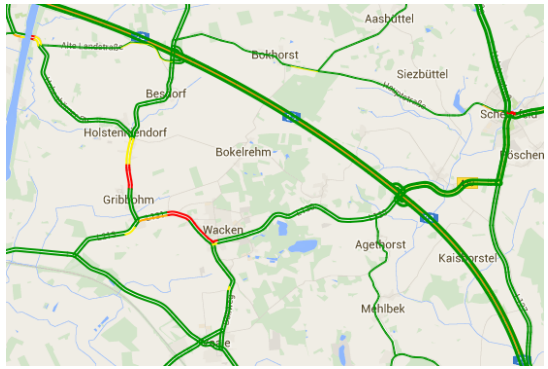
- Monitoring traffic situation on access roads during festival
- Depiction of travel times on access roads

Applications
Traffic monitoring at major events (2)

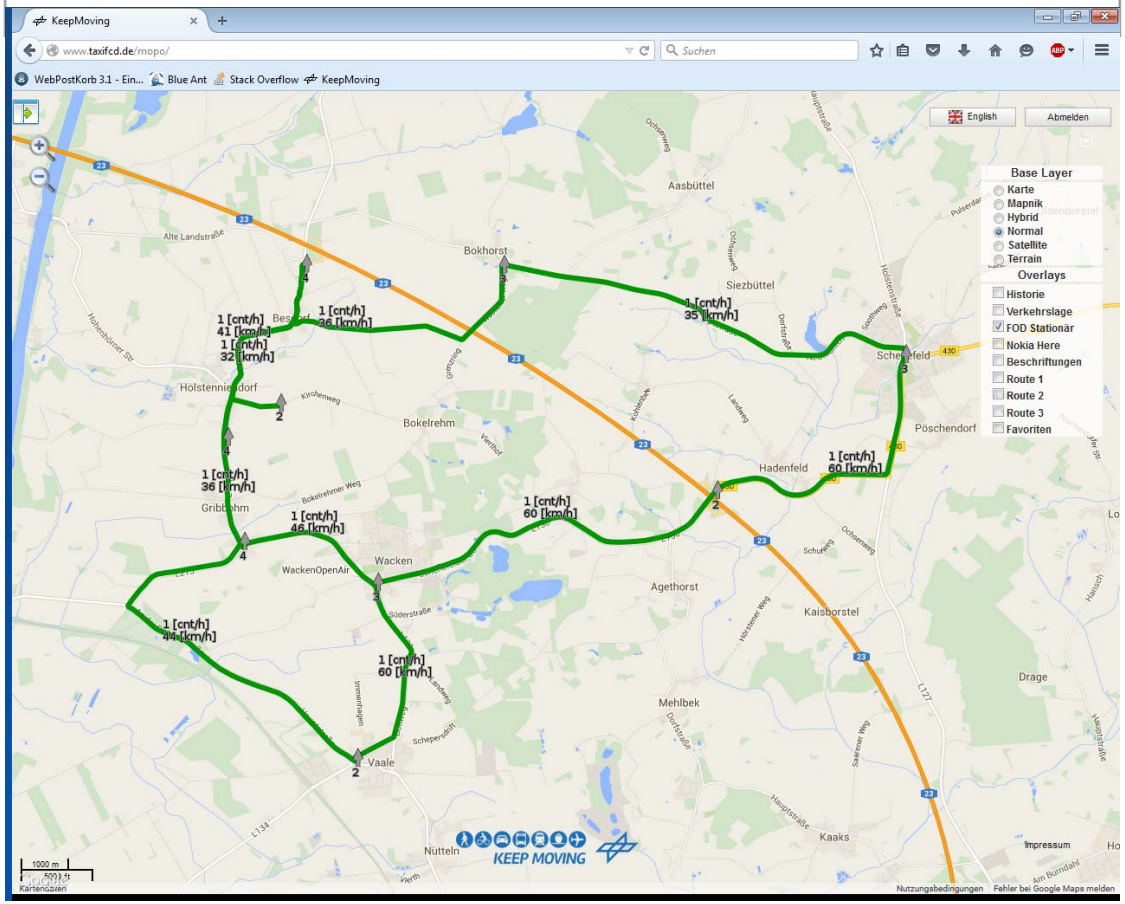
Results:

- Bluetooth based traffic monitoring was helpful to get an impression of actual traffic situation

31.07.2015, 05:21 p.m.



Blubb Nr.	Det. Dauer	Verhältnis zu Referenz	Tendenz	Detektionen
1	22,40	(0,5)	(0,8)	5
2	22,40	(1,3)	(2,4)	19
3	22,40	(1,0)	(1,0)	42



Conclusion
DYNAMIC characteristics

- Traffic participants and their smart devices as **multisensory platform** for traffic detection
  - Detection is **independent from traffic mode** (vehicles, pedestrians and bikes can be detected)
- **Rising equipment rate** of devices with detectable communication services (Bluetooth, WiFi, …)
  - more and more travelers carry **detectable smart devices** (e.g. Smartphones)
  - **20 - 40 %** motorized vehicles have detectable devices on board
- floating car observers equipped with **low-cost detection** units
  - detector price ~200€ (vs. ~10.000€ inductive loop)
- **No** intrusive **stationary infrastructure** required
- **Ad hoc installation** enables rapid deployment
  - traffic management in **specific occasions** (e.g. roadworks, bypass, huge events)
  - hazard management with **minimal preparation time**
- More **accurate OD** and **route choice** extraction (also sub road network!)

Future Prospects

- Currently proof of technology
- Further field tests are carried out / planned
  - **Taxi Fleet in Berlin (01 June - 31 August)**
    - broad-scale campaign with 30 equipped taxis
    - Goals: area-wide traffic monitoring, travel times and velocities, OD
  - **Wacken 2016 (04 - 06 August)**
    - mobile traffic monitoring at festival site is planned (staff equipped with smartphones)
    - Goals: pedestrian flow monitoring and path usage
- In 2017 operationalising
  - Development of market-ready product
  - Further field tests (e.g. football game)

Contact

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